

## What is Claimed:

- 1                   1.     A method of determining range from a moving platform to an  
2 emitter comprising the steps of:
  - 3                   (a)     receiving a RF signal from the emitter;
  - 4                   (b)     counting a number of phase reversals of the received RF signal  
5 during a period of time;
  - 6                   (c)     measuring a Doppler frequency during the period of time; and
  - 7                   (d)     determining the range to the emitter based on both the number  
8 of phase reversals counted in step (b) and the Doppler frequency measured in step  
9 (c).
- 1                   2.     The method of claim 1 wherein  
2                   step (b) includes counting the number of phase reversals of the  
3 received RF signal during the period of time the moving platform traverses a  
4 distance.
- 1                   3.     The method of claim 2 further including the step of:
  - 2                   (e)     measuring the distance traversed by the moving platform  
3 during the period of time; and
- 4                   step (d) includes determining the range to the emitter based on the  
5 number of phase reversals counted in step (b), the Doppler frequency measured in  
6 step (c) and the distance measured in step (e).
- 1                   4.     The method of claim 3 wherein  
2                   measuring the distance includes obtaining geographic position data at  
3 each end of the distance traversed by the moving platform, using one of an inertial  
4 navigation system (INS), a Global Positioning System (GPS), and a combination of  
5 an INS and GPS.

1                   5.       The method of claim 3 wherein step (d) includes  
2                   forming a first triangle having (i) a first side being a function of the  
3 distance traversed by the moving platform, (ii) a second side being a function of the  
4 counted number of phase reversals of the received RF signal, and (iii) a third side  
5 being a function of a Law of Cosines, in which an angle  $\alpha$  between the first side and  
6 the second side is a function of the measured Doppler frequency, and

7                   determining the range to the emitter using the formed first triangle.

1                   6.       The method of claim 5 wherein step (d) includes

2                   forming an equilateral triangle in which (i) a base of the equilateral  
3 triangle is the third side of the first triangle, and (ii) two equal sides of the  
4 equilateral triangle, each side denoted by R, are a function of the angle  $\alpha$ , and

5                   determining the range to the emitter includes combining a side R of  
6 the equilateral triangle and the second side of the first triangle.

1                   7.       The method of claim 3 wherein

2                   measuring the distance includes measuring the distance during a  
3 predetermined period of time having a value ranging between 1 second and 20  
4 seconds.

1                   8.       The method of claim 3 wherein

2                   step (c) of measuring the Doppler frequency includes measuring  
3 variations in the Doppler frequency during the period of time, the variations denoted  
4 by  $\Delta f_d$ ,

5                   in which  $1/\Delta f_d$  is approximately a width between 3dB power points of a  
6 main lobe of an autocorrelation function of the Doppler frequency.

1                   9.       The method of claim 2 wherein

2                   receiving the RF signal includes receiving one of a pulsed Doppler  
3 signal and a CW signal.

10. The method of claim 2 further including the steps of:

2 (e) mixing the received RF signal with an oscillator signal to  
3 produce an intermediate frequency (IF) signal;

4 (f) converting the IF signal into a digital signal;

5 (g) storing the digital signal in a memory; and

6 (h) providing the digital signal for counting the number of phase  
7 reversals in step (b).

11. The method of claim 10 wherein

2                    step (e) includes mixing the received RF signal with a numerically  
3                    controlled oscillator (NCO) signal to produce a phase coherent IF signal.

1                    12.     A method of determining range from a moving platform to an  
2     emitter comprising the steps of:

3 (a) receiving a RF signal from the emitter during a period of time  
4 the moving platform traverses a distance, the distance denoted by  $b$ ;

5 (b) determining a carrier wavelength,  $\lambda$ , of the RF signal;

6 (c) counting a number of phase reversals of the received RF signal  
7 during the period of time, the number denoted by N;

8 (d) determining a range differential,  $\Delta R$ , between the moving  
9 platform and the emitter during the period of time, in which

$$10 \qquad \Delta R = N\lambda;$$

11 (e) measuring a Doppler frequency,  $f_d$ , during the period of time;  
12 and

13 (f) determining the range to the emitter based on the distance  $b$ ,  
14 the range differential  $\Delta R$  and the Doppler frequency  $f_d$ .

1                   13.     The method of claim 12 wherein  
2                   determining the range to the emitter includes calculating an angle  $\alpha$   
3     using the following expression:

4                              $fd = v * \cos\alpha * 1/\lambda$

5                   wherein

6      $v$  is a velocity vector of the moving platform transversing the distance  $b$ ,

7      $\alpha$  is an angle formed between the velocity vector  $v$  and the range differential  $\Delta R$ .

1                   14.     The method of claim 13 wherein

2                   determining the range to the emitter includes forming a first triangle  
3     having (i) a first side being the distance  $b$ , (ii) a second side being  $N\lambda$ , and (iii) a  
4     third side,  $d$ , computed by using a Law of Cosines including the first side, the angle  $\alpha$   
5     and the second side.

1                   15.     The method of claim 14 wherein

2                   determining the range to the emitter includes forming an equilateral  
3     triangle in which (i) a base of the equilateral triangle is  $d$  and (ii) two equal sides of  
4     the equilateral triangle, each denoted by  $R$ , are a function of the angle  $\alpha$  and the  
5     base  $d$ , and

6                   determining the range to the emitter includes combining  $R$  and  $N\lambda$ .

1                   16.     An apparatus, installed onboard a moving platform, for  
2     determining range from the moving platform to an emitter comprising

3                   a receiver for receiving a RF signal from the emitter,

4                   an analog to digital converter (ADC) for converting the received RF  
5     signal into a digital signal,

6                   a memory for storing the digital signal provided by the ADC, and

7                   a processor coupled to the memory for extracting the stored digital  
8 signal, and (a) counting a number of phase reversals of the digital signal during a  
9 period of time, (b) measuring a Doppler frequency during the period of time, and (c)  
10 determining the range to the emitter using both the counted number of phase  
11 reversals and the measured Doppler frequency.

1                   17.     The apparatus of claim 16 including

2                   a GPS receiver coupled to the processor for obtaining geographic  
3 position of the moving platform, and

4                   the processor determining a distance traversed by the moving platform  
5 during the period of time based on the geographic position obtained from the GPS  
6 receiver.

1                   18.     The apparatus of claim 16 including

2                   a mixer coupled between the receiver and the ADC for converting the  
3 received RF signal into an IF signal,

4                   wherein the ADC converts the IF signal into the digital signal.

1                   19.     The apparatus of claim 18

2                   wherein the mixer is coupled to a NCO for providing a coherent signal  
3 to the mixer, and

4                   the mixer combines the received RF signal and the coherent signal to  
5 provide the IF signal.

1                   20     The apparatus of claim 16

2                   wherein the processor measures a plurality of Doppler frequencies  
3 during the time period, and

4                   the processor includes an autocorrelation function for autocorrelating  
5 the plurality of Doppler frequencies measured during the time period and obtaining  
6 an averaged Doppler frequency based on results of the autocorrelation function.